On the effect of Magnetospheric Shielding on the Lunar Hydrogen Cycle. O.J. Tucker[1], W.M. Farrell[1] and A.R. Poppe[2], [1]NASA/GSFC, Greenbelt, MD, USA, [2]University of California, Berkeley, CA, USA, (orenthal.j.tucker@nasa.gov).

Introduction: The hydrogen cycle on the Moon is a potential resource for future lunar exploration. When the Moon traverses Earth's magnetosphere the mean ion flux is ~2.4×10^8 cm^{-2}s^{-1} in the magnetosheath and ~0.22×10^8 cm^{-2}s^{-1} in the magnetotail, compared to the solar wind (SW) value of ~1.9×10^8 cm^{-2}s^{-1} [1]. The lunar hydrogen content is expected to be depleted during full Moon because H_2 has a short lifetime for escape, ~72 minutes. This decrease in hydrogen should be observable in the 3-micron feature on the surface on near side of the Moon [2,3] and in observations of the H_2 exosphere [4,5]. The Monte Carlo approach described in Tucker et al., [2019] [6] is used to estimate surface hydroxylation and the H_2 exosphere during full Moon.

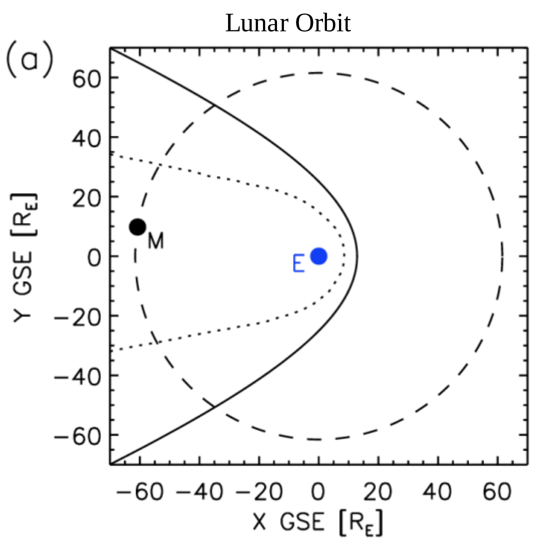

Figure 1: Moon orientation during ARTEMIS measurements from of sheath (solid curve) and magnetotail (dotted curve) [1].

Methodology: Tucker et al., [2019] showed that hindered diffusion of implanted hydrogen caused by physical and chemical trapping is consistent with the observed global OH surface concentrations [2] and H_2 exosphere [4]. In this approach, a myriad of defects leads to the formation of hydroxyls during the H to H_2 diffuse pathway is modeled using a distribution of activation energies [7].

Unfortunately, current observations cannot distinguish between surficial OH/H_2O, and observations of the H_2 exosphere are limited [4,5]. Therefore, the role of H to H_2 as a dominant pathway in the hydrogen cycle remains under examination [2,7,8,9,10]. To this end, we use the approach in Tucker et al., [2019] to predict the hydrogen content during full Moon for future model-observation comparisons. Three simulations will be presented: 1) SW source turned off in the tail, 2) ion source rates in the sheath and tail taken from ARTEMIS [1], and 3) ARTEMIS flux and energy spectra used to investigate the effect of implantation depth on degassing.

Results: Figure 2 shows results from a simulation using a proton flux for the tail 2 orders of magnitude smaller than typical SW showing the relative decrease of OH and H_2 during full Moon. We will present results of the simulation cases. H_2 is loss over a short timescale compared to time spent in the tail. Observations during full Moon can provide useful constraints for models of the hydrogen cycle.

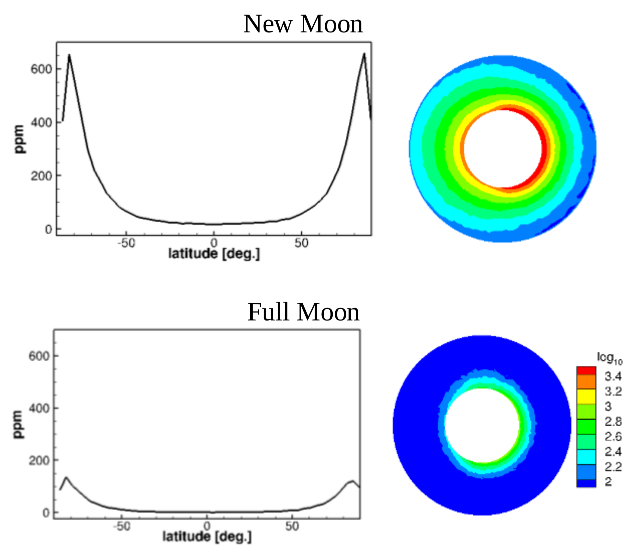

Figure 2: Model results of surface concentration(left) and exospheric H_2(right) during new and full Moon.

[1] Poppe et al., [2018] JGR, Planets, 123.
[2] Li and Milliken, [2017] Science Advances, 3.
[3] Cho et al., [2018] JGR Planets, 123.
[4] Stern et al., [2013] Icarus, 226.
[5] Thampi et al., [2015] PSS, 106.
[6] Tucker et al., [2019] JGR, Planets, 124.
[7] Farrell et al., [2017], Icarus, 255.
[8] Bandfield et al., [2018] Nature Geoscience, 11.
[9] Jones et al., [2018] GRL, 45.
[10] Wohler et al., [2017] Sci Adv., 3.